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Fishery Leaflet 17

Chicago 54, Ill. * Rev. July 1945

CONSTRUCTION OF FARM PONDS

By John Blosz, Regional Supervisor of Fish Culture, and
Richard F. Dittman, Associate Engineer, Region IV

Farm fish ponds, under proper management, can contribute materially to our Nation's food supply. This is particularly true in the southern States where most pondfishes attain within one year sufficient size for table use. Farmers who own a pond site will find that with a little labor and non-critical materials they can build a small fish pond which will produce enough fish to supplement their meat supply and furnish minerals and vitamins required in the diet to maintain health. A farm fish pond one acre in size, properly fertilized and managed, can supply up to 200 or more pounds of fish a year. Production will be reduced in northern regions in proportion to the shortening of the growing season and lower water temperatures. Some States require that land owners obtain permits for the impoundment of waters. Where such laws exist, permission from the proper State authorities will be necessary before a fish pond can be constructed.

The Fish and Wildlife Service provides fish for stocking farm ponds and cooperates with the State Fish and Game Departments, the Soil Conservation Service, and the Agricultural Extension Service to provide fish when these agencies assist the farmer directly.

In some States, the Agricultural Adjustment Agency, in conjunction with other soil conservation practices, assists the farmers financially in the building of dams for farm ponds by making payments for soil moving at the rate of 15¢ per cubic yard for the first 2,000 cubic yards, and 10¢ per cubic yard for additional yardage. Under this payment plan the height of the dam is limited to 15 feet. In some instances, payment is made for concrete structures pertinent to the construction of the dam. The Agricultural Extension Service in some States, as well as the Agricultural Adjustment Agency, provides for technical advice through Soil Conservation Service districts or otherwise in the selection of the pond site and construction of the dam. In Missouri and Ohio, the conservation departments are prepared to offer direct engineering advice and assistance in construction. The Fish and Wildlife Service will also furnish technical assistance through the superintendents of the various fish-cultural stations.

Information dealing with the fertilization, stocking, and management of farm fish ponds, and application forms to requisition fish for stocking purposes, may be obtained upon request from the Regional Offices of the Fish and Wildlife Service located in the Weatherly Building, Portland, Oregon;

or Post Office Box 1306, Albuquerque, New Mexico; Plymouth Building, Minneapolis, Minnesota; 318 Glenn Building, Atlanta, Georgia; or 1105 Blake Building, Boston, Massachusetts. Information may also be had by writing to the Division of Game-fish and Hatcheries, Fish and Wildlife Service, Merchandise Mart Building, Chicago, Illinois.

POND OR WATER AREA

The selection of the pond site is important. Primary considerations are: an adequate but not excessive water supply, a pond bottom which will hold water, a location where the dam can be constructed economically, and satisfactory and sufficient materials nearby with which to build the embankment. Secondary considerations are: reasonably fertile soil for the pond bottom, erosion control on the watershed area, gently sloping ground particularly for the pool area, and freedom from heavy overflow or flash floods. Low areas too wet to farm often make ideal pond sites for wildlife and fish.

The source of water for the pond should receive first consideration. In order to reduce the cost of construction and of fertilization after the pond is full, it is best to consider only small streams or springs or direct runoff from pastures and woodlands. It is not necessary to have a constant overflow from the pond but there must be sufficient water to fill the pond and to maintain it at a rather stable level. If it is impossible to find a site where water is flowing during the summer months, then the pond should have sufficient depth to provide adequate space for the fish when evaporation lowers the amount of water-surface. A ratio of approximately 10 to 15 acres of watershed to one surface acre of pool water should be established for pasture land when the water source is only direct rainfall runoff, with a slightly larger ratio for woodland and a smaller one for lands under cultivation. These ratios will, of course, vary with the rainfall and the slope of the land, so they should be determined for each pond.

After the general location has been chosen with respect to the water supply, the next step is to select the actual site for the pond and dam. Areas where gravel beds exist or where limestone outcrops are present should be avoided as the ground may not hold water. Water draining into the pond from adjacent lands should be free of silt. If it is not possible to locate the pond where there is a wide fringe of grass or woodlands bordering the edges, it would be desirable to create such a strip so that the silt will be deposited before it reaches the pond.

The cost of construction will increase as the height of the embankment or depth of the water increases. An embankment 10 feet high will require approximately three and one-half times as much dirt as one 5 feet high. Hence, it is well to limit the depth of water to some reasonable figure unless abundant funds are available for construction. Expense must be considered also when large streams are blocked, as additional spillway capacity and freeboard on the embankment will be required as insurance against failure of the dam during floods. The minimum depth at the drain structure should be from 6 to 8 feet in the Southeast, from 8 to 9 feet in the Middle West where the winters are more severe, and from 8 to 10 feet in those areas west of the Mississippi River Valley and the tier of States from Texas to Nebraska. In

the northern-most States and in certain mountainous areas where thick ice and heavy snows occur, 12 to 14 feet or more in depth may be necessary to prevent loss of fish during the winter. There may be some modification of these depths desired in certain areas due to improper distribution of the water supply, excessive evaporation, or temperature ranges, etc., but generally speaking they will provide suitable water under average conditions. If a heavy demand is made on the pond for stock watering, then, it may be necessary to have deeper water, to carry both the fish and stock over protracted dry periods.

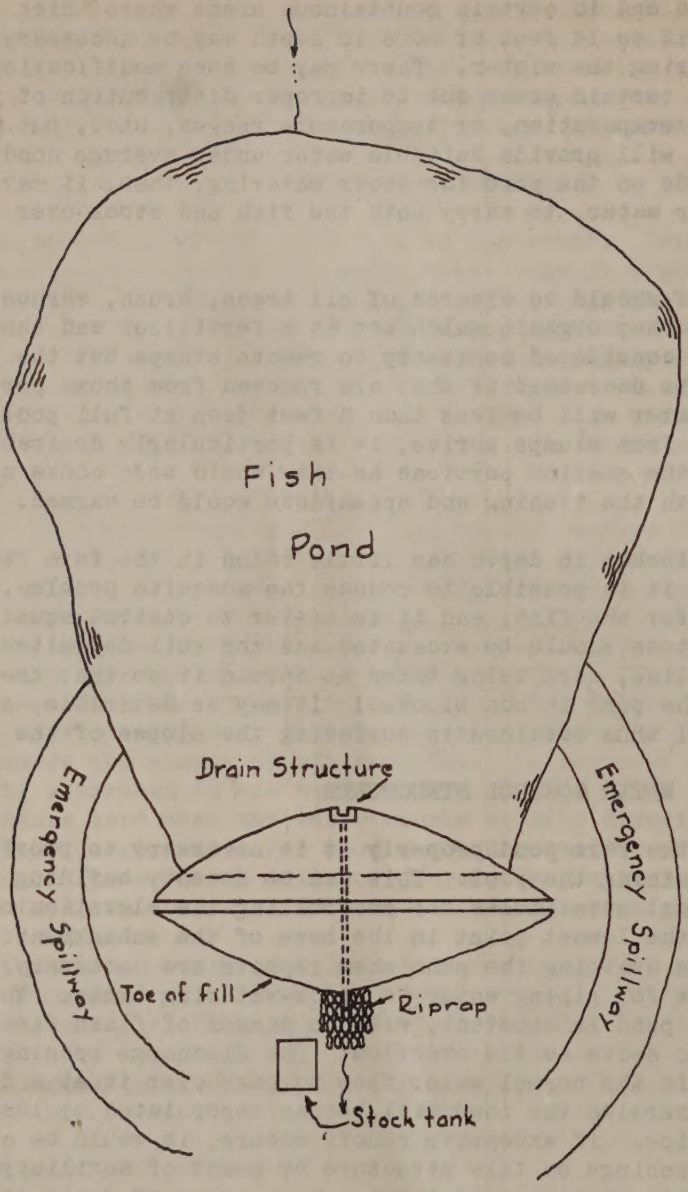
The pond area itself should be cleared of all trees, brush, shrubs, and debris. Leaf mold and other organic mulch act as a fertilizer and should be retained. It is not considered necessary to remove stumps but the yearly maintenance will often be decreased if they are removed from those portions of the pool where the water will be less than 3 feet deep at full pool. In locations where sprouts from stumps thrive, it is particularly desirable to remove the stumps from the shallow portions as they would soon choke up that part of the pond and both the fishing and appearance would be harmed.

Water less than 18 inches in depth has little value in the farm fish pond. By eliminating shallows it is possible to reduce the mosquito problem, increase the forage area for the fish, and it is easier to control aquatic vegetation. These portions should be excavated and the soil deposited uniformly along the shore line, care being taken to spread it so that the normal surface drainage into the pond is not blocked. It may be desirable, also, to use some of the top-soil thus obtained in surfacing the slopes of the embankment.

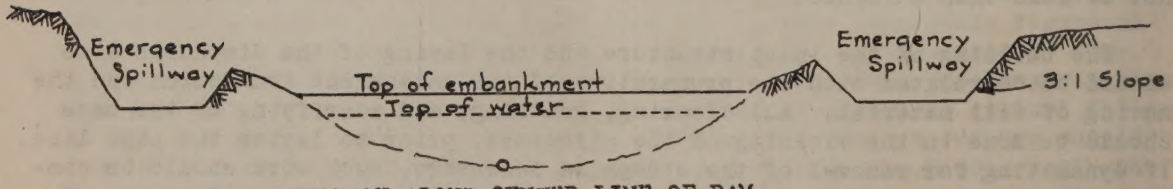
WATER CONTROL STRUCTURES

In order to manage the farm pond properly it is necessary to provide some means for completely draining the pool. This can be done by building a drain structure, with additional attachments for controlling the elevation of the surface of the pond at the lowest point in the base of the embankment. Such a structure is useful in draining the pond when repairs are necessary, and for providing facilities for piping water to stock-watering tanks. When the source of water for the pond is constant, with no danger of flash floods, this structure can be made to serve as the overflow. The discharge opening should be large enough to permit the normal water flow to pass over it at a depth of less than 2 inches. Otherwise the pond will become depopulated by loss of fish through the discharge pipe. If excessive runoff occurs, it would be advisable to provide additional openings on this structure by means of auxiliary spillways around the end of the dam, as discussed later. Some types of drain structures are illustrated by the accompanying sketches. The size of the outlet pipe should be determined by someone familiar with the requirements, but it should not be less than 6 inches.

The building of the inlet structure and the laying of the discharge line should be correlated with the preparation of the embankment foundation and the moving of fill material. All clearing, grubbing, and scarifying of the base should be done in the vicinity of the structure, prior to laying the pipe line. If dynamiting for removal of the stumps is necessary, such work should be completed for a distance of at least 75 feet around the structure before any of the work is completed.



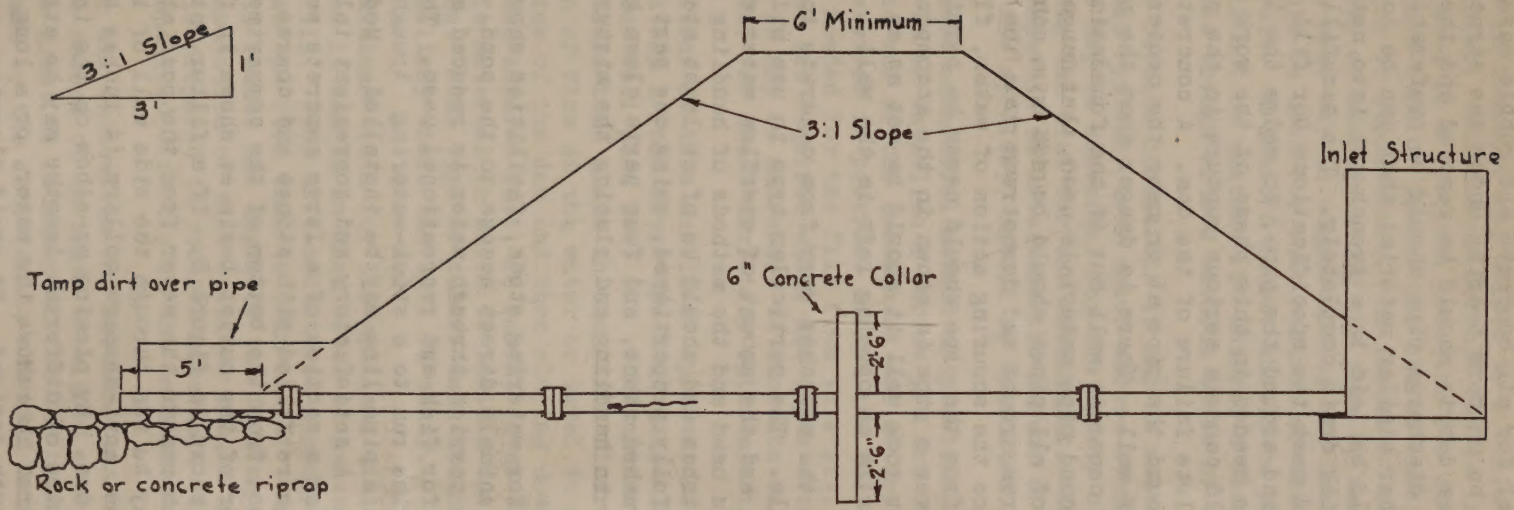
GENERAL PLAN OF POND



SECTION ALONG CENTER LINE OF DAM

Figure 1

Consult an engineer as to the minimum size of emergency spillways. Use the excavated material for building the earth dam.



TYPICAL SECTION THROUGH FILL
AND CONTROL STRUCTURE

Figure 2

The natural foundation material for all concrete and rubble masonry should be firm so that there will be uniform bearing under the structure. Top soil, organic matter, and other debris should be removed and the loose dirt tamped firmly in place. The discharge pipe should be preferably iron-base, spiralweld, transite, or other similar material that can be joined by substantial connections. It should be laid in a trench cut into natural ground and so set that the pond will drain completely. The backfill material for the trench should be clean and meet the specifications for fill dirt. It should be tamped firmly under and around the pipe, to wedge the latter tightly in place. Extreme care is needed in this phase of the work as uneven settlement or movement could cause a serious rupture in the pipe-line and could eventually lead to complete failure of the dam. A concrete collar (fig. 2) should also be poured around the pipe at or near the centerline of the dam to act as a seepage cutoff wall. There is danger that the pipe may shear where it passes through the concrete wall but if the foundation is good, the backfill properly made, and sound pipe materials used, that danger is greatly reduced. The outlet end of all pipes should be set on a concrete or rock riprap base and a suitable area around and downstream from the outlet end of the pipe riprapped to reduce the scouring action of water, flowing through the pipe. The discharge from the pipe should never be permitted to fall on unprotected earth. Whenever a pipe is shown in the accompanying drawings to pass through a concrete or rock wall it should be set as an integral part of the wall, not placed later in an opening left in the wall.

The inlet structures shown on the sketches vary from concrete to steel pipe, or a combination of materials. The particular type to use will be determined by the funds available and the amount of overflow water which will have to be handled. The materials used and the methods of handling and forming should be as shown on the sketches and should be of at least standard quality. Concrete should be carefully proportioned, using one part Portland cement, two parts sand or fine crushed stone, and four parts clean gravel or crushed rock. Standard practices in handling and placing the mixture should be followed.

If the pond is to serve also for watering stock, facilities should be provided that will not allow the animals direct access to the pond. If this is done, the danger from diseases carried through water is reduced and the pond is kept in better condition for fish and recreational uses. The pond and dam can be fenced and a pipeline run to a stock-watering trough below the dam. Figure 5 shows how such a pipe-line may be installed. Modifications of this arrangement are possible. A satisfactory and convenient inlet for the water pipe can be made by using a section of a large concrete sewer pipe, or a concrete box about 3 feet square filled with stones and coarse gravel for a filter, the water being piped from the bottom of the compartment. The pipe should pass through the floor of the outlet basin as shown in figure 3 and through the cutoff collar as shown in figure 5. If a filter intake box is not used it may be desirable to remove the water from the pond at a higher level. In this case, the pipe may be run through the side wall of the intake basin and one or two concrete, anti-seepage collars (4 inches by 2½ feet) spaced several feet apart in the dam. By placing an elbow on the intake end of the line, either sections of pipe of different lengths may be attached according to the depth it is desired to remove the water, or a long piece of pipe may be swiveled to any depth desired. To avoid clogging, a funnel covered with screen or hardware cloth should be attached. The funnel may be

10 inches in diameter and welded to a collar or section of pipe fitted for the inlet. Where considerable debris is present, the funnel opening may be placed in a vertical position for easy cleaning with a long-handled brush. This type of intake has the advantage of being easily removable for repairs or replacement. An important consideration is to reduce the possibility of seepage along the pipe by tamping the fill material around it in the same way as suggested for the drain pipe line. Heavy-duty water pipe should be used for that section of the line where replacement would be difficult. A shutoff faucet should be placed on the outlet so that water will not be wasted. If desired a float cutoff valve may be installed to keep the trough filled without waste of water.

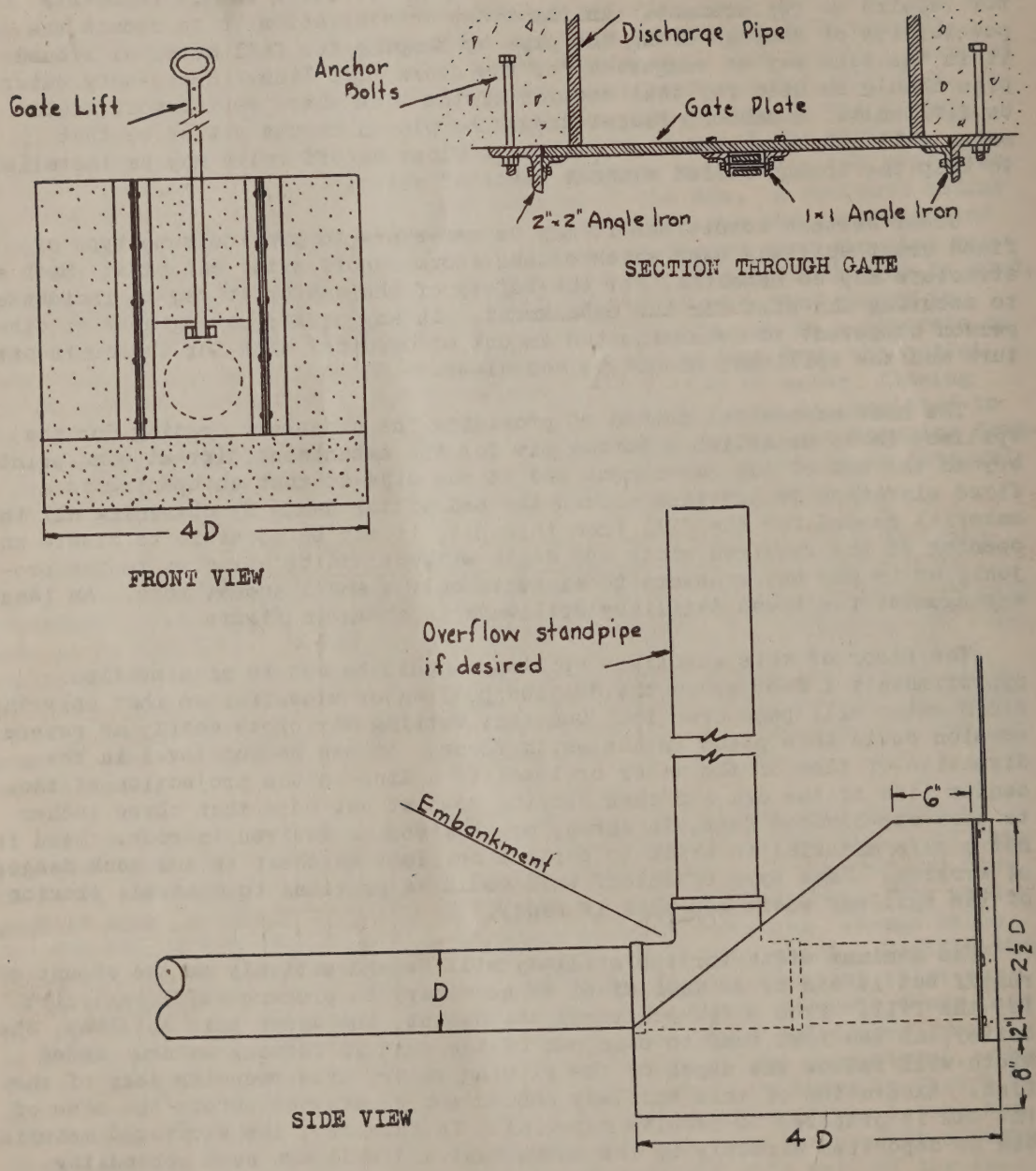
Under certain conditions it may be necessary to provide some type of fixed crest spillway over which excess storm runoff water can pass. Such a structure may be essential for the safety of the dam or it may be incidental to securing the dirt for the embankment. In any event, an engineer or other person competent to determine the amount of opening, both for the drain structure and the spillway, should be consulted.

The most economical method of providing the necessary opening for the spillway is to establish a borrow pit for the embankment dirt at some point beyond the end of the embankment and at one side so that an opening to a fixed elevation is provided around the end of the dam. By obtaining all the material needed for the fill from this pit, it may be possible to create an opening of the required width and depth without additional cost to the project, or it may be necessary to excavate only a small amount more. An ideal arrangement for these auxiliary spillways is shown in figure 1.

The floor of this auxiliary spillway should be cut to an elevation approximately 1 foot above the desired pool water elevation so that only the storm water will pass over it. Constant wetting may prove costly as severe erosion could take place in the earth floor. It can be cut level in the direction of flow of the water or level to a line on the projection of the center line of the dam and then sloping down at not more than three inches to each one-hundred feet, in earth, or as steep as desired in rock. Sand is not a safe material in which to build a spillway as there is too much danger of erosion. Some type of cutoff wall could be provided to control, erosion of the spillway where the soil is sandy.

The minimum width for the spillway will depend entirely on the amount of runoff but it can be as much wider as necessary to procure sufficient dirt for the fill. From a fish-cultural standpoint, the wider this spillway, the better, as the fish tend to swim out of the pond in flowing water. Added width will reduce the depth of the flowing water, thus reducing loss of the fish. Excavation of this spillway should not be started before the base of the dam is prepared to receive material. In this way, the excavated material can be deposited directly in the embankment and will not need rehandling.

After all excavation and leveling has been done, the floor and slopes should be seeded or sprigged to a good permanent grass to reduce the erosion. Centipede grass is recommended for the South, but the choice of grass can be better made by the individual, who will know what type does best on the particular soil.

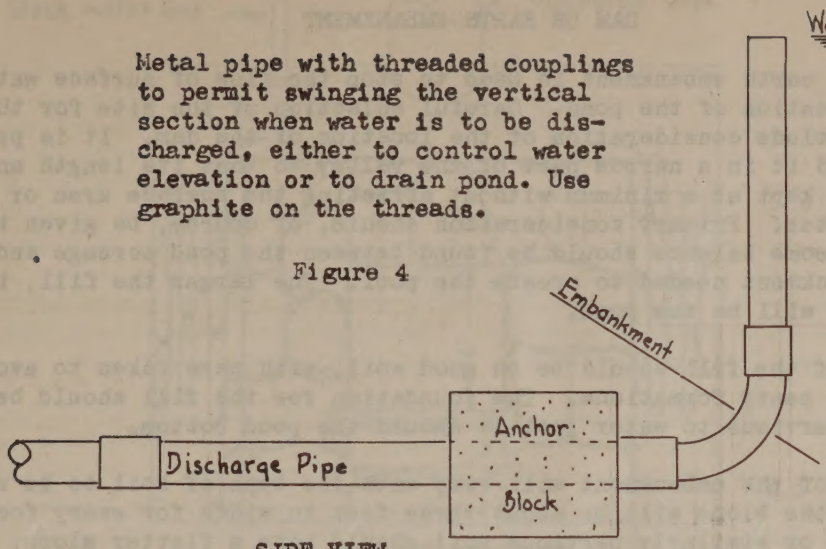


GATE DRAIN WITH STAND-PIPE

Figure 3

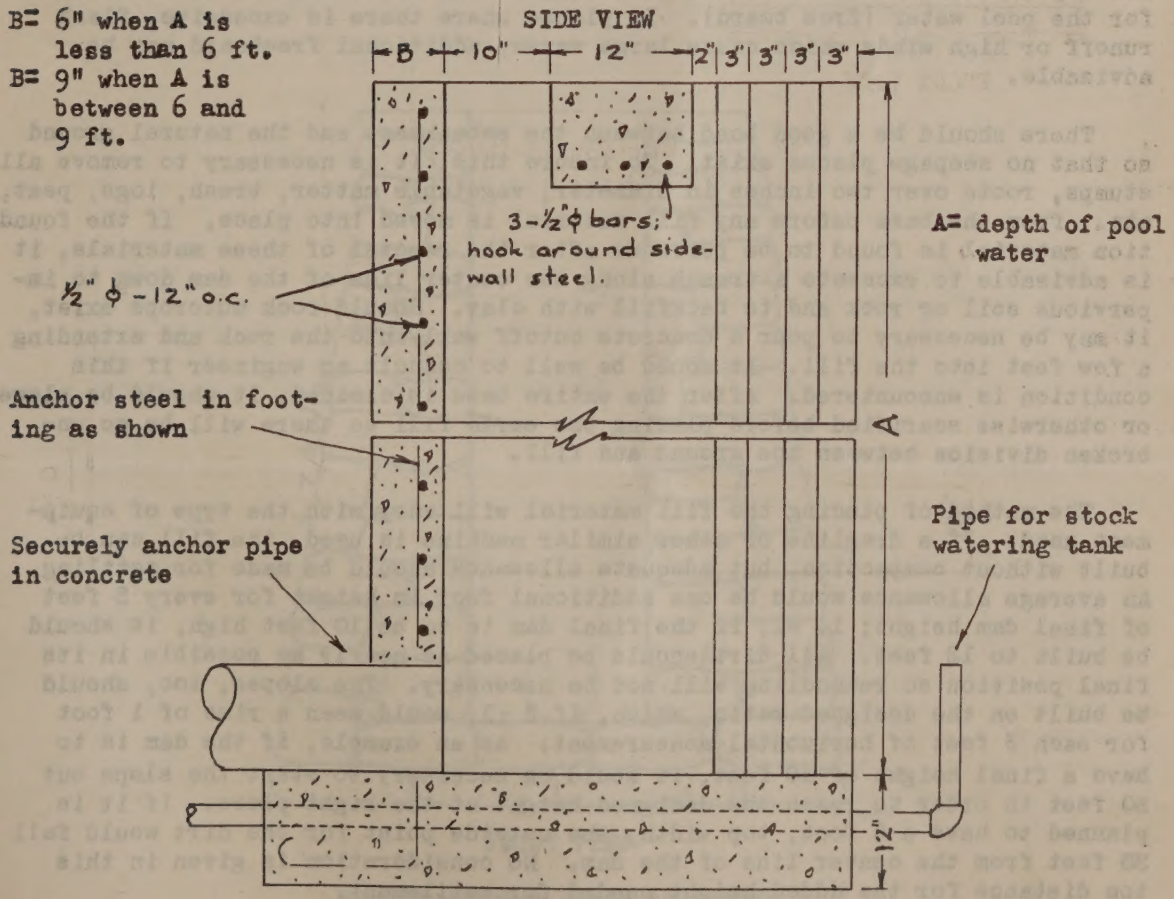
Metal pipe with threaded couplings to permit swinging the vertical section when water is to be discharged, either to control water elevation or to drain pond. Use graphite on the threads.

Figure 4



SIDE VIEW

B= 6" when A is less than 6 ft.
B= 9" when A is between 6 and 9 ft.



CONCRETE INTAKE STRUCTURE

Figure 5

DAM OR EARTH EMBANKMENT

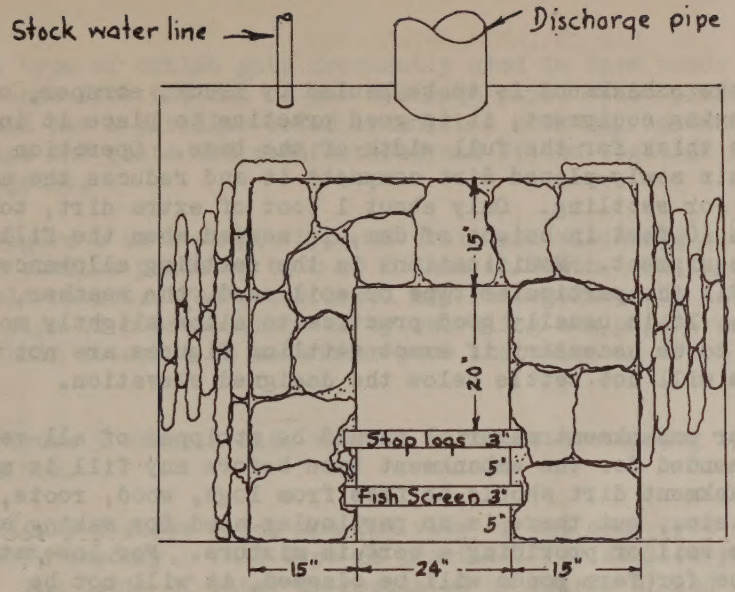
The dam or earth embankment is used to stop the flow of surface water and for the creation of the pond. Careful selection of the site for the pond should include consideration of the location of the dam. It is preferable to build it in a narrow part of the valley so that its length and height will be kept at a minimum without affecting the surface area or depth of the pond water. Primary consideration should, of course, be given to the pond site but some balance should be found between the pond acreage and the amount of embankment needed to create the pool. The larger the fill, the more expensive will be the pond.

The base of the fill should be on good soil, with care taken to avoid gravel beds or peaty formations. The foundation for the fill should be relatively impervious to water just as should the pond bottom.

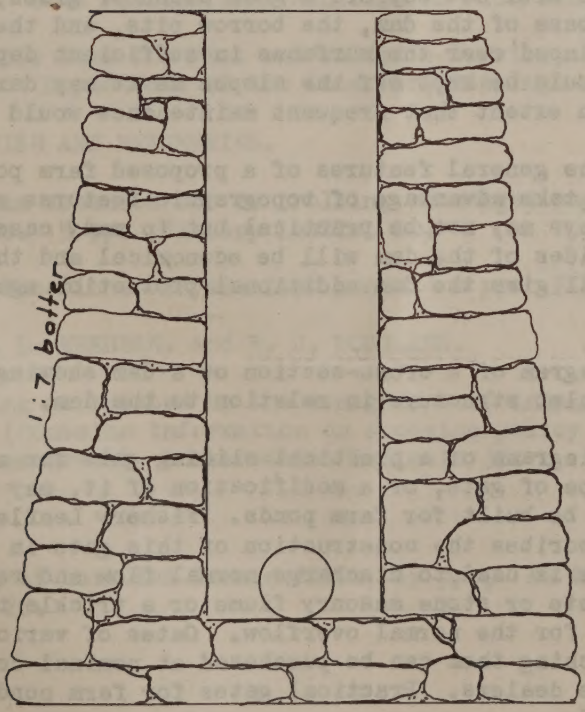
The shape of the embankment will vary with the type of soil to be used but generally the slope will be about three feet in width for every foot in height. Sandy or similarly pervious soil should have a flatter slope, perhaps five feet in width to one in height. The top width should not be less than six feet and it can be wider to suit the needs of the owner. Often such fills are used as roadways, in which case the top should be at least eight feet wide. The top of the dam should be not less than 3 feet above the desired elevation for the pool water (free board). In places where there is excessive, flash runoff or high winds which cause large waves, additional freeboard may be advisable.

There should be a good bond between the embankment and the natural ground so that no seepage places exist. To insure this, it is necessary to remove all stumps, roots over two inches in diameter, vegetable matter, trash, logs, peat, etc., from the base before any fill material is moved into place, If the foundation material is found to be pervious after the removal of these materials, it is advisable to excavate a trench along the center line of the dam down to impervious soil or rock and to backfill with clay. Should rock outcrops exist, it may be necessary to pour a concrete cutoff wall into the rock and extending a few feet into the fill. It would be well to consult an engineer if this condition is encountered. After the entire base is cleaned, it should be plowed or otherwise scarified before placing the earth fill so there will be no unbroken division between the ground and fill.

The method of placing the fill material will vary with the type of equipment used. If a dragline or other similar machine is used, the fill can be built without compaction, but adequate allowance should be made for settling. An average allowance would be one additional foot in height for every 5 feet of final dam height; i. e., if the final dam is to be 10 feet high, it should be built to 12 feet. All dirt should be placed as nearly as possible in its final position so rehandling will not be necessary. The slopes, too, should be built on the designed ratio, which, if 3 :1, would mean a rise of 1 foot for each 3 feet of horizontal measurement. As an example, if the dam is to have a final height of 10 feet, it would be necessary to start the slope out 30 feet in order to reach the designed height at the right place. If it is planned to have a 6 foot, top width, the outside point for the dirt would fall 33 feet from the center line of the dam. No consideration is given in this toe distance for the added height needed for settlement.



TOP VIEW



FRONT VIEW

RUBBLE MASONRY DRAIN STRUCTURE

Figure 6

If the dirt for the embankment is to be hauled by truck, scraper, or other similar dirt-moving equipment, it is good practice to place it in layers about 8 inches thick for the full width of the base. Operation of the equipment over this newly-placed dirt compacts it and reduces the amount needed to compensate for settling. Only about 1 foot of extra dirt, to allow for settling in 10 feet in height of dam, is needed when the fill is compacted by the equipment. Modifications in the settling allowance may be necessary to fit the particular type of soil used, the weather, and operating conditions. It is usually good practice to allow slightly more dirt than is thought to be necessary if exact settling figures are not available, so that the dam will not settle below the designed elevation.

The borrow pit for embankment material should be stripped of all vegetation, etc., as recommended for the embankment base before any fill is moved to the dam. All embankment dirt should be free from logs, wood, roots, vegetation, rubbish, etc., but there is no particular need for making an exact analysis of the soil or providing a certain mixture. For low-water dams, as most of those for farm ponds will be classed, it will not be necessary to place an impervious core in the embankment if the side slopes are made flat enough.

When all the material has been placed for the embankment, it is desirable, but not necessary, to grade the surfaces reasonably smooth. Slopes and tops should be sprigged or seeded to a permanent grass to give protection from erosion. If the soil will not support a good stand of grass, then the topsoil strippings from the base of the dam, the borrow pits, and the shallow edges of the pool should be placed over the surfaces in sufficient depth to support grass. Livestock should be kept off the slopes as it may damage the grass and embankment to such an extent that frequent maintenance would be required.

Figure 1 shows the general features of a proposed farm pond. Ponds may vary considerably to take advantage of topographic features at the sites. Two emergency spillways may not be practical but in many cases the use of the dirt from both sides of the dam will be economical and the additional width of spillway will give the dam additional protection against damage from storm waters.

Figure 2 is a diagram of a cross-section of a dam showing the discharge and drain pipe and inlet structure in relation to the dam.

Figure 3 shows diagrams of a practical sliding gate for a farm pond or small lake. This type of gate, or a modification of it, may be used on any height dam likely to be built for farm ponds. Fishery Leaflet 65, Fish and Wildlife Service, describes the construction of this gate in detail. Unless an overflow standpipe is used to discharge normal flow and regulate the pond water-level, a concrete or stone masonry flume or a trickle tube will be necessary to provide for the normal overflow. Gates of various sizes and accessories for attaching them can be purchased at nominal cost through hardware dealers and pipe dealers. Practical gates for farm ponds vary in cost from about $18 to $36.

A type of outlet gate frequently used in farm ponds is a cast-iron plate that fits the end of the drainage pipe. This plate is hinged to the pipe and has a circular catch in which a hook may be inserted for opening. The pipe and plate are manufactured and fitted together to give a water-tight joint.

Figure 4 is a simple type of drain and discharge outlet that is practical in shallow ponds up to 6 or 8 feet in depth. It is commonly called the canfield outlet. The water level may be regulated by the length of the upright pipe or pipe sections or by swiveling the pipe from its upright position by a chain attached to an anchor-post installed in front of the discharge tube.

Figure 5 shows a side view of a concrete stop-log type of drain and discharge box.

Figure 6 shows a top and end view of the same type of outlet constructed of rubble masonry. This type is practical for shallow ponds with 6 to 10 feet head. The depth of water is regulated by boards placed in slots. It has the advantage of serving as a fish screen which can be inserted in slots in front of the stop boards when the pond is drained. By providing an extra set of slots, two sets of stop-boards tamped with clay between will provide a water-tight barrier which may be advantageous in some sections of the country to prevent loss of water.

SOME PUBLICATIONS RELATING TO FISH CULTURE

(Obtainable from the Fish and Wildlife Service, United States Department of the Interior, Washington 25, D. C.)

BRANCH OF GAME-FISH AND HATCHERIES.

Use of sodium arsenite for controlling submerged vegetation in fish ponds. 5 pp. Fishery Leaflet 10.

List of publications on farm fish ponds. 6 pp. Fishery Leaflet 24.

JAMES, M. C., O. L. MEEHEAN, and E. J. DOUGLASS.

Fish stocking as related to the management of inland waters. 22 pp., 9 figs. (Contains information on stocking policy and various management measures.) Conservation Bulletin 35.

MARKUS, HENRY C.

Propagation of bait and forage fish. 19 pp., 10 figs. Fishery Circular 28.